Version of Amended Claims with Markings to Show Changes Made:

Please amend Claims 19, 24, 31 and 41 as follows and add Claims 42-46.

19. (Amended)A method of depositing a film on a substrate comprising the steps of:
maintaining supercritical carbon dioxide from a first module in contact with the substrate to remove a sorbate selected from the group consisting of an absorbate and an adsorbate from the substrate, thereby forming a desorbed substrate; and
depositing the film on the desorbed substrate from a second module [without exposing the desorbed substrate to a material which forms a nonvolatile sorbate], wherein the substrate is transferred from the first module to the second module through a valve without exposure of the substrate to a surrounding environment.

24. (Amended) The method of claim [19] 20 further comprising the step of maintaining the supercritical carbon dioxide and a solvent in contact with the substrate to remove a residue selected from the group consisting of a photoresist, a photoresist residue, and an etch residue from the substrate prior to the step of depositing the metal film.

31. (Amended) An apparatus for depositing a metal film on a substrate comprising:
a. a transfer module;
b. a supercritical processing module coupled to the transfer module;
c. a metal deposition module; [and]
d. a vacuum module coupling the metal deposition module to the transfer module; and
e. means for transferring the substrate between the supercritical processing module and the metal deposition module.

41. (Amended) An apparatus for depositing a metal film on a substrate comprising:
a. a transfer module comprising an entrance and a first robot;
b. a supercritical processing module coupled to the transfer module;
c. a metal deposition module; and
d. a vacuum module coupling the metal deposition module to the transfer module, the vacuum module comprising a vacuum chamber and a second robot, wherein the first robot and the second robot are configured to transfer the substrate between the supercritical processing module and the metal deposition module.

42. (New) An apparatus comprising:

a. a front transfer module comprising one or more supercritical modules configured to treat a substrate with a supercritical solution;

b. a back transfer module couple to the front transfer module, the back transfer module comprising one or more deposition modules configured to deposit a layer of material onto the treated substrate; and

c. means for transferring the substrate between the front transfer module and the back transfer module without exposing the substrate to the environment.

43. (New) The apparatus of claim 42, wherein the means for transferring the substrate between the first transfer module and the second transfer module comprises one or more transfer robots.

44. (New) The apparatus of claim 42, further comprising a valve for isolating the substrate within the one of the front transfer module and the back transfer module.

45. (New) The apparatus of claim 42, further comprising a loader module for introducing the substrate.

46. (New) The apparatus of claim 45, wherein the loader module is coupled to the front transfer module.

REMARKS

Applicant respectfully requests further examination and reconsideration in view of the above amendments and arguments set forth fully below. Claims 1-41 were previously pending in the instant application. Within the Office Action, Claims 1-41 have been rejected. By way of the above amendment, Claims 19, 24, 31 and 41 have been amended and Claims 42-46 have been added. Claims 1-46 are now pending in this application.

Rejections Under 35 U.S.C. § 102(e)

Within the Office Action, Claims 19 and 24 have been rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,024,801 to Wallace et al. (hereinafter "Wallace et al."). Specifically, it is stated within the Office Action that Wallace et al. disclose the step of maintaining supercritical CO_2 and one or more additives in contact with a substrate to remove impurities and depositing a film, without exposing the substrate to the environment.

Wallace et al. teach a method for providing an improved passivation surface for the reduction of stiction between contacting parts in a micro-mechanical device. [Wallace et al.; Abstract] Wallace et al. teach that supercritical fluids can be used to remove organic residues and that after the surface is cleaned, the surface remains in the same sealed chamber, [Wallace et al.; Column 8, lines 65-68 and Column 9, lines1-2] wherein the cleaned surface is subsequently passivated with a fluorochemical, such as Perfluorodecanic Acid (PFDA) and Perfluoropolyether (PFPE). [Wallace et al.; Column 6, lines 58-66] However, Wallace et al. fail to teach or suggest using a first module to clean a substrate with supercritical fluid and a second module for depositing a layer on the cleaned substrate, as currently recited in the independent Claim 19.

Specifically, Claim 19 is directed to method of depositing a film on a substrate comprising the steps of maintaining supercritical carbon dioxide, from a first module, in contact with the substrate to remove a sorbate selected from the group consisting of an absorbate and an adsorbate from the substrate, thereby forming a desorbed substrate and depositing a film on the desorbed substrate from a second module, wherein the substrate is transferred from the first module to the second module through a valve without exposure of the substrate to a surrounding environment. As described in detail above, Wallace et al. fail to teach or suggest treating a substrate surface to a supercritical solution in a first module and depositing a film on the treated substrate in a second module, wherein the substrate is transferred from the first module to the second module without exposure of the substrate to the environment. For at least these reasons,

the independent Claim 19 is allowable over the teachings of Wallace et al.

Claims 24 now depends directly on the independent Claim 19. As described above, the independent Claim 19 is allowable over the teachings of Wallace et al. Accordingly, Claim 24 is allowable as being dependent on an allowable base claim.

Rejections Under 35 U.S.C. § 103(a)

Within the Office Action, Claims 1-3, 10, 11, 12, 14, 16, 17, 18, 20-23 and 25-30 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,242,165B1 to Vaartstra (hereinafter "Vaartstra") in view of U.S. Patent No. 6,024,801 to Wallace et al. (hereinafter "Wallace et al."). Specifically, it is stated within the Office Action that Vaartstra discloses the step of providing supercritical CO_2 in order to remove impurities from a surface of a substrate which may include additives. It is also stated within the Office Action that Wallace et al. teach not exposing the substrate to the environment in order to prevent contamination of the substrate. It is further stated within the Office action that although Vaartstra does not disclose depositing metal, Vaartstra discloses a high aspect ratio via and it is conventional to fill high aspect ratio vias with metal. The applicant respectfully traverses this rejection for the following reasons.

Vaartstra teaches using a supercritical compositions for removing organic materials. [Vaartstra; Abstract and Column 4, lines 26-29] However, Vaartstra fails to teach or suggest removing oxides from a metal surface, such as recited in the independent Claims 1 and 14.

As previously stated, Wallace et al. do not teach or suggest depositing metal surface cleaned with a supercritical solution, removing metal oxides from the metal surface with a supercritical solution, nor a method of treating a surface or a substrate with a supercritical solution and subsequently depositing a metal layer onto the treated surface, wherein the treated surface is a metal surface. In summary, Vaartstra, Wallace et al. nor their combination teach or suggest the features recited in the independent Claims 1 and 14.

Specifically, the independent Claim 1 is directed to a method of depositing a metal film on a substrate comprising the steps of maintaining supercritical carbon dioxide and a chelating agent in contact with the substrate to remove an oxide layer from a metal surface of the substrate, thereby forming a precleaned substrate and depositing the metal film on the precleaned substrate without exposing the precleaned substrate to a material which oxidizes the metal surface of the precleaned substrate. As described in detail above, neither Vaartstra, Wallace et al. nor their combination teach or suggest removing an oxide layer from a metal surface of the substrate and depositing the metal film thereon. For at least these reasons, the independent Claim 1 is

allowable over the teachings of Vaartstra, Wallace et al. and their combination.

Claims 2-13 are all dependent on the independent Claim 1. As described above, Claim 1 is allowable over the teachings Vaartstra, Wallace et al. and their combination. Accordingly, Claims 2-13 are all also allowable as being dependent on an allowable base claim.

The independent Claim 14 is directed to a method of depositing a metal film on a substrate comprising the steps of maintaining supercritical carbon dioxide and an amine in contact with the substrate to remove an oxide layer from a metal surface of the substrate, thereby forming a pre-cleaned substrate and depositing the metal film on the precleaned substrate without exposing the precleaned substrate to a material which oxidizes the metal surface of the precleaned substrate. As described in detail above, neither Vaartstra, Wallace et al. nor their combination teach or suggest removing an oxide layer from a metal surface of the substrate and depositing the metal film thereon. For at least these reasons, the independent Claim 1 is allowable over the teachings of Vaartstra, Wallace et al. and their combination.

Claims 15-18 are all dependent on the independent Claim 14. As described above, Claim 14 is allowable over the teachings Vaartstra, Wallace et al. and their combination. Accordingly, Claims 15-18 are all also allowable as being dependent on an allowable base claim.

Claim 19 is directed to a method of depositing a film on a substrate comprising the steps of maintaining supercritical carbon dioxide from a first module in contact with the substrate to remove a sorbate selected from the group consisting of an absorbate and an adsorbate from the substrate, thereby forming a desorbed substrate and depositing the film on the desorbed substrate from a second module, wherein the substrate is transferred from the first module to the second module through a valve without exposure of the substrate to a surrounding environment. As described in detail above, neither Vaartstra, Wallace et al. nor their combination teach or suggest treating a substrate surface to a supercritical solution in a first module and depositing a film on the treated substrate in a second module, wherein the substrate is transferred from the first module to the second module without exposure of the substrate to the environment. For at least these reasons, the independent Claim 19 is allowable over the teachings of Vaartstra, Wallace et al. and their combination.

Claims 20-24 are all dependent on the independent Claim 19. As described above, Claim 19 is allowable over the teachings Vaartstra, Wallace et al. and their combination. Accordingly, Claims 20-24 are all also allowable as being dependent on an allowable base claim.

The independent Claim 25 is directed to a method of depositing a metal film on a substrate comprising the steps of maintaining supercritical carbon dioxide in contact with the substrate to remove a sorbate selected from the group consisting of an absorbate and an adsorbate

from the substrate maintaining the supercritical carbon dioxide and a chelating agent in contact with the substrate to remove an oxide layer from a metal surface of the substrate and subsequently depositing the metal film on the substrate without exposing the substrate to a first material which forms a nonvolatile sorbate prior to depositing the metal film and without exposing the substrate to a second material which forms the oxide prior to depositing the metal film. As described in detail above, neither Vaartstra, Wallace et al. nor their combination teach or suggest treating a metal substrate surface with a supercritical solution in order to remove oxides from the surface before depositing metal thereon. For at least these reasons, the independent Claim 25 is allowable over the teachings of Vaartstra, Wallace et al. and their combination.

Claims 26 and 27 are both dependent on the independent Claim 25. As described above, Claim 25 is allowable over the teachings Vaartstra, Wallace et al. and their combination. Accordingly, both Claims 26 and 27 are both also allowable as being dependent on an allowable base claim.

The independent Claim 28 is directed to a method of depositing a metal film on a substrate comprising the steps of maintaining supercritical carbon dioxide in contact with the substrate to remove a sorbate selected from the group consisting of an absorbate and an adsorbate from the substrate maintaining the supercritical carbon dioxide and an amine in contact with the substrate to remove an oxide layer from a metal surface of the substrate and subsequently depositing the metal film on the substrate without exposing the substrate to a first material which forms a nonvolatile sorbate prior to depositing the metal film and without exposing the substrate to a second material which forms the oxide prior to depositing the metal film. As described in detail above, neither Vaartstra, Wallace et al. nor their combination teach or suggest treating a metal substrate surface to a supercritical solution in order to remove oxides from the surface before depositing metal thereon. For at least these reasons, the independent Claim 28 is allowable over the teachings of Vaartstra, Wallace et al. and their combination.

Claims 29 and 30 are both dependent on the independent Claim 28. As described above, Claim 28 is allowable over the teachings Vaartstra, Wallace et al. and their combination. Accordingly, both Claims 29 and 30 are both also allowable as being dependent on an allowable base claim.

Within the Office Action, Claims 4, 5, 7-9, 13 and 15 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,242,165B1 to Vaartstra (hereinafter "Vaartstra") in view of U.S. Patent No. 6,024,801B1 to Wallace et al. (hereinafter "Wallace et al.") as applied to Claim 1, and further in view of U.S. Patent No. 6,228,563B1 to Starov et al.

(hereinafter "Starov et al."). It is stated within the Office action that Starov et al. disclose using supercritical CO_2 with the addition of organic and inorganic acids and a chelating agent, such as EDTA, to remove residues from a substrate, including copper oxides from copper surfaces. It is further stated within the Office Action the removal of aluminum oxide is also disclosed, and that one of ordinary skill in the art would be motivated to have combined the disclosure of Starov et al. with the process taught by Vaartstra in view of Wallace et al., because Vaartstra in view of Wallace et al. disclose that a substrate can include other material layers, such as conductor layers and that copper is conventional in the art.

Further, within the Office Action, Claim 6 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,242,165B1 to Vaartstra (hereinafter "Vaartstra I") in view of U.S. Patent No. 6,024,801 to Wallace et al. (hereinafter "Wallace et al.") in view of U.S. Patent No. 6,228,563 B1 to Starov et al. (hereinafter "Starov et al.") and further in view of U.S. Patent No. 6,149,828 to Vaartstra (hereinafter "Vaartstra II"). Within the Office Action, it is stated that while Vaartstra I in view of Wallace et al . and Starov does not disclose the recited acids, Vaartstra II discloses that acetic acid may be an organic acid additive and, therefore, it is concluded within the Office Action that one of ordinary skill in the art would have been motivated to use acetic acid in a process taught by Vaartstra I in view of Wallace et al.

Claims 4, 5, 7-9 and 13 are dependent on the independent Claim 1 and Claim 15 is dependent on the independent Claim 14. For all of the reasons given above, the independent Claim 1 and the independent Claim 14 are both allowable over the teachings of Vaartstra I and Wallace et al., Starov et al., Vaartstra II and their combination. Accordingly, Claims 4, 5 7-9, 13 and 15 are all also allowable as being dependent on an allowable base claims.

Within the Office Action, Claims 31-41 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,228,563B1 to Starov et al. (hereinafter "Starov et al.") in view of U.S. Patent No. 6,024,801 to Wallace et al. (hereinafter "Wallace et al."). It is stated within the Office Action that Starov et al. disclose an apparatus which includes a transfer module including a first robot, a supercritical processing module, a second module and a vacuum module couple to the supercritical processing module and having a second robot. Within the Office Action it is also stated that Starov et al. do not teach a metal deposition module as the second module. Within the Office Action it is further stated that Wallace et al. disclose a deposition step taking place without withdrawing the substrate from the vacuum environment and discloses that a cluster tool and a supercritical processing chamber can be placed between process chambers.

Starov et al. teach an apparatus and method for removing residues from a substrate by exposing the substrate to a vapor phase solvent in combination with megasonic energy and/or

plasma to remove the residue. [Starov et al.; Abstract] Starov et al. state that oxidation of such metallic components will form oxides such as aluminum or titanium oxides, which are ceramic residues that are extremely difficult to remove". [Starov et al.; column 1, lines 55-58] Starov et al., therefore, states that low processing temperatures are preferred to reduce the formation of such oxides. [Starov; column 7, lines 23-33] While Starov et al. teach that it can be beneficial to purge a chamber with an inert gas prior to treating of the substrate in order to prevent the formation of oxides, such as copper oxide, during the treatment of the substrate, Starov et al. do not teach or suggest an apparatus that is configured with multiple processing modules, at least one of which is configured to treat a substrate to a supercritical CO_2 (viz. a high pressure module) and at least one of which is configured to deposit metal or other low vapor pressure materials (viz. a low pressure module). Nor do Starov et al. teach or suggest means for transferring a substrate between the aforementioned processing modules without exposing the substrate to the environment, as currently recited in the independent Claims 31, 41 and 42.

Wallace et al. also do not teach or suggest an apparatus with multiple processing modules, at least one of which is configured to treat a substrate to a supercritical solution and at least one of which is configured to deposit material on a surface of the substrate after treating the substrate to the supercritical solution.

The independent Claim 31 is directed to an apparatus for depositing a metal film on a substrate comprising a transfer module, a supercritical processing module coupled to the transfer module, a metal deposition module, a vacuum module coupling the metal deposition module to the transfer module and means for transferring the substrate between the supercritical processing module and the metal deposition module. As described in detail above, neither Starov et al., Wallace et al. nor their combination teach or suggest an apparatus with a supercritical processing module and a metal deposition module that are coupled and means to transfer the substrate between the supercritical processing module and the metal deposition module. For at least these reasons, the independent Claim 31 is allowable over the teachings of Starov et al., Wallace et al. and their combination.

Claims 32-40 are all dependent on the independent Claim 31. As described above, Claim 31 is allowable over the teachings Starov et al., Wallace et al. and their combination. Accordingly, Claims 32-40 are all also allowable as being dependent on an allowable base claim.

The independent claim 41 is directed to an apparatus for depositing a metal film on a substrate comprising a transfer module comprising an entrance and a first robot, a supercritical processing module coupled to the transfer module, a metal deposition module and a vacuum module coupling the metal deposition module to the transfer module, the vacuum module

comprising a vacuum chamber and a second robot, wherein the first and second robots transfer the substrate between the supercritical processing module and the metal deposition module. As described in detail above, neither Starov et al., Wallace et al. nor their combination teach or suggest an apparatus with a supercritical precessing module and a metal deposition module with robots for transferring the substrate between the precessing modules. For at least these reasons, the independent Claim 41 is allowable over the teachings of Starov et al., Wallace et al. and their combination.

The new independent Claim 42 is directed to an apparatus comprising a front transfer module comprising one or more supercritical modules configured to treat a substrate with a supercritical solution, a back transfer module coupled to the front transfer module, the back transfer module comprising one or more deposition modules configured to deposit a layer of material onto the treated substrate, means for transferring a substrate between the front transfer module and the back transfer module without exposing the substrate to the environment.

Claims 43-46 are all dependent on the independent Claim 42. As described above, Claim 42 is allowable over the teachings Starov et al., Wallace et al. and their combination. Accordingly, Claims 43-46 are all also allowable as being dependent on an allowable base claim.

For all the reasons given above, the Applicant respectfully submits that Claims 1-46 are now in a condition for allowance, and allowance at an early date would be appreciated. Should the Examiner have any questions or comments, the Examiner is encouraged to call the undersigned at (408) 530-9700 to discuss the same so that any outstanding issues can be expeditiously resolved.

Respectfully submitted,
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